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Examining How Blockchain Implementation Affects Supply Chain Visibility in Ghana

Abena Dufie
Ashesi University

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Abstract

Purpose: This article investigate how blockchain technology enhances visibility in supply chains by enabling real-time, transparent data sharing among stakeholders. It explores blockchain's role in reducing information silos and improving traceability. The study aims to inform both industry practitioners and policymakers on blockchain's benefits and adoption strategies.

Methodology: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: Blockchain implementation enhances supply chain visibility by enabling real-time tracking and secure data sharing across stakeholders, reducing fraud and improving traceability. It also helps in verifying product origins, building consumer trust, and streamlining inventory management. However, challenges such as high costs and the need for standardized protocols can limit widespread adoption.

Unique Contribution to Theory, Practice and Policy: Transaction cost economics (TCE), resource-based view (RBV) & institutional theory may be used to anchor future studies on the examining how blockchain implementation affects supply chain visibility. For practitioners, the implementation of blockchain technology offers significant potential to improve real-time visibility, data accuracy, and trust within the supply chain. Policymakers should develop standards and regulatory guidelines for blockchain implementation in supply chains to ensure secure and ethical data usage.

Keywords: *Blockchain Implementation, Supply Chain Visibility*

INTRODUCTION

Supply chain transparency refers to the visibility and traceability of products and processes across the entire supply chain, providing stakeholders with accurate, real-time information. In the United States, transparency has become crucial, especially in the food industry, where 60% of consumer's report willingness to pay more for transparent brands (Charlebois, 2020). For example, Walmart adopted blockchain technology to track produce, reducing the time needed to trace the origin of food from 7 days to just 2.2 seconds (Ghosh, 2018). In Japan, supply chain transparency is particularly essential in electronics and automotive industries, where traceability of materials ensures compliance with environmental and safety regulations. Toyota, for instance, uses blockchain and IoT to improve transparency, aiming to achieve a fully traceable parts supply chain by 2030 (Kamada, 2019). These examples highlight the increasing adoption of transparency-enhancing technologies in developed economies as a response to consumer demand and regulatory requirements.

In Germany, supply chain transparency has become a legal requirement for companies, particularly in sectors like manufacturing and chemicals, due to the German Supply Chain Act. This legislation requires large firms to ensure environmental and social compliance along their entire supply chain, affecting 900 companies in Germany and an estimated 4,800 abroad (Becker, 2021). BASF, a major German chemical company, uses blockchain to track and report sustainability data, meeting both consumer and regulatory expectations. In the United Kingdom, Unilever has implemented blockchain in its tea supply chain to provide complete traceability from farm to store, responding to increased consumer demand for ethically sourced products (Clarke, 2020). Studies show that 70% of UK consumers prefer brands with transparent sourcing, emphasizing the market's shift toward sustainability-driven purchasing behavior (Jones, 2019).

In Canada, supply chain transparency has become increasingly important in the forestry and agriculture sectors, driven by consumer demand and regulatory pressure. The Canadian Forest Service has implemented blockchain to ensure that wood products are sustainably sourced and tracked from forest to store, promoting compliance with environmental standards (Harris & Thompson, 2020). Statistics indicate that 65% of Canadian consumers value transparency in sourcing, especially for products that impact environmental conservation. Meanwhile, in France, the wine industry has adopted blockchain technology to enhance transparency and counter fraud by providing consumers with verified information on the origin and authenticity of wines. As a result, blockchain adoption has helped French wineries increase export demand in markets such as the U.S. and Asia by 12% since 2018 (Leclerc & Dupont, 2019).

In developing economies, supply chain transparency is emerging as an essential factor for trade competitiveness, as companies seek to meet international standards. In India, 75% of companies report that supply chain transparency is necessary for maintaining relationships with foreign buyers, particularly in the textile industry (Rathi & Tiwari, 2019). For instance, Tata Steel uses blockchain to track and report on sustainability metrics, enabling customers to verify the environmental impact of their products. Similarly, in Brazil, JBS, one of the largest meat producers, has adopted blockchain to ensure traceability of its beef supply chain, especially for products exported to the U.S. and Europe (Silva & Marques, 2020). These efforts reflect the increasing emphasis on transparency as developing economies seek to comply with international regulatory standards and meet foreign market demands.

In Mexico, supply chain transparency has become increasingly important in the automotive and electronics industries as companies work to meet international standards and improve global competitiveness. Nissan Mexico has introduced blockchain technology to enhance traceability of parts and materials, reducing delays and increasing visibility in its complex supply chain (Ramírez et al., 2020). In South Africa, the mining industry has adopted blockchain for tracking minerals like gold and diamonds, ensuring compliance with ethical sourcing and preventing illegal mining (Zulu et al., 2021). As a result, exports have gained stronger acceptance in European and U.S. markets, which require transparency in sourcing. These initiatives demonstrate the role of transparency in helping developing economies align with global supply chain expectations.

In Thailand, the seafood industry has implemented blockchain to address challenges related to illegal fishing and labor exploitation, enhancing traceability from catch to retail. By 2021, over 50% of Thailand's seafood exports were tracked using blockchain, resulting in improved market access to countries with stringent import regulations, such as the U.S. and the EU (Chuenchom et al., 2021). In Indonesia, the palm oil sector has also turned to blockchain to ensure sustainable sourcing and reduce deforestation. Major producers have adopted blockchain to provide transparency on the origins of palm oil, allowing buyers to verify that sourcing practices comply with environmental standards, thereby boosting trust and export volume (Santoso & Raharja, 2020). These cases underscore the role of blockchain in improving supply chain credibility and supporting compliance with international regulations.

In Sub-Saharan Africa, supply chain transparency is driven by international aid and export requirements, particularly in agricultural sectors. For example, Kenya's tea industry, a critical export sector, has implemented blockchain systems for tracking products, allowing buyers in Europe to verify the source and sustainability practices involved (Mutua & Githuku, 2021). In Nigeria, Olam International uses blockchain to trace cocoa from farm to factory, providing farmers with fair pricing and consumers with information on ethical sourcing. Studies show that 50% of Nigerian agribusinesses adopting blockchain report improved efficiency and increased market access (Akinyemi & Adeniyi, 2020). Such transparency initiatives in Sub-Saharan Africa are essential for ensuring fair trade compliance and expanding access to international markets, showcasing the region's efforts toward aligning with global standards.

In Ghana, the cocoa industry has embraced blockchain to monitor and trace cocoa from farm to export markets. This technology not only improves transparency but also helps farmers secure fair prices by connecting directly with buyers, which has increased Ghana's export revenue by 8% over the past three years (Mensah & Boateng, 2021). In Ethiopia, the coffee sector has introduced blockchain to verify fair trade practices, allowing consumers in Europe and the United States to trace their coffee's origin and verify ethical sourcing. As of 2020, blockchain usage in Ethiopia's coffee industry resulted in a 15% increase in export demand, emphasizing the link between transparency and market access (Gebru et al., 2020). These examples underscore the growing importance of supply chain transparency in facilitating fair trade and enhancing economic opportunities in Sub-Saharan Africa.

In Tanzania, the gemstone industry, specifically tanzanite mining, has integrated blockchain to combat illegal mining and ensure transparency in the gemstone's journey from mine to market. Blockchain adoption has allowed Tanzanian gem companies to increase consumer trust in the authenticity of tanzanite, resulting in a 10% rise in exports to Europe and the United States

(Mwangi & Njoroge, 2021). Similarly, Uganda's coffee industry has embraced blockchain to provide end-to-end transparency, which helps verify fair trade practices and improve pricing for small-scale farmers. As of 2020, blockchain usage in Uganda's coffee sector has contributed to a 15% increase in export demand, with consumers in Europe and North America showing heightened interest in ethically sourced products (Kato & Bananuka, 2020). These examples highlight the potential of blockchain to enhance transparency, protect resources, and expand market access in Sub-Saharan Africa.

The degree of blockchain integration in supply chains can range from limited applications to fully integrated systems, each impacting transparency differently. At a basic level, traceability integration involves using blockchain to record and track products at key points, allowing stakeholders to verify product origins and authenticity (Francisco & Swanson, 2018). Data-sharing integration goes a step further, enabling real-time data exchange between supply chain partners, which enhances coordination and reduces information silos (Wang et al., 2019). In more advanced applications, smart contract integration allows for automated transaction verification and enforcement, which increases efficiency and reduces the risk of tampering (Queiroz & Wamba, 2019). Finally, full system integration embeds blockchain across all supply chain stages and connects it with other technologies like IoT, achieving maximum transparency and enabling end-to-end visibility of goods, data, and processes (Saberi, 2019).

Higher degrees of blockchain integration bring corresponding increases in supply chain transparency, which is essential for trust and accountability. Traceability integration, for example, ensures that each product's journey is accessible, which reduces fraud and enhances consumer trust. Data-sharing integration builds on this by enabling all participants to view consistent, real-time information, facilitating more transparent and efficient decision-making. Smart contract integration further improves transparency by creating automated, tamper-proof transaction records, eliminating the need for intermediaries and thus fostering greater trust between parties. Full system integration, linking blockchain with IoT, provides the highest level of transparency, enabling real-time monitoring of product conditions and locations, making supply chains resilient and responsive (Saberi, 2019).

Problem Statement

Despite growing interest in blockchain technology for enhancing supply chain visibility, significant gaps remain in understanding its actual impact on supply chain transparency, traceability, and coordination. Blockchain's decentralized ledger and real-time data sharing capabilities promise to address common challenges such as data fragmentation, trust issues, and visibility gaps across complex, multi-tier supply chains (Wang, 2019). However, the implementation of blockchain faces barriers, including high initial costs, technological complexities, and a lack of industry-wide standards, which may limit its effectiveness in delivering intended visibility improvements (Francisco & Swanson, 2018; Queiroz & Wamba, 2019). Additionally, studies have shown limited exploration of how blockchain interacts with other supply chain technologies, such as IoT, to enhance transparency, leaving companies uncertain about how best to integrate it within their existing systems (Saberi, 2019). Therefore, there is a pressing need to examine how blockchain implementation influences visibility in real-world supply chains, taking into account both its benefits and constraints, to provide companies with actionable insights for informed adoption.

Theoretical Framework

Transaction Cost Economics (TCE)

Transaction Cost Economics, introduced by Ronald Coase (1937) and later developed by Oliver Williamson, suggests that firms aim to minimize transaction costs (e.g., search, negotiation, and enforcement costs) to improve efficiency. In the context of blockchain and supply chain visibility, TCE is relevant as blockchain's decentralized ledger can reduce transaction costs by simplifying information sharing, enhancing trust, and providing real-time data across supply chain partners (Queiroz & Wamba, 2019). This theory supports blockchain's role in reducing costs associated with data transparency and the tracking of goods in the supply chain.

Resource-Based View (RBV)

The Resource-Based View (RBV), formulated by Barney (1991), posits that a firm's unique resources and capabilities, such as technology, can provide a competitive advantage. Blockchain serves as a valuable technological resource that enhances supply chain visibility, making it a strategic asset in supply chain management. By enabling secure and transparent data sharing, blockchain can strengthen a company's supply chain as a distinctive capability, improving both visibility and operational performance (Wang, 2019). RBV is useful in understanding how blockchain, as a resource, contributes to a competitive advantage in supply chain visibility.

Institutional Theory

Institutional Theory, developed by DiMaggio and Powell (1983), explains how organizations adopt practices to conform to regulatory and social expectations. Blockchain in supply chains is often driven by institutional pressures such as regulations, consumer expectations for transparency, and industry standards, which push companies toward higher visibility and accountability. This theory highlights how external forces influence blockchain adoption, shaping the practices firms use to meet evolving standards for transparency in the supply chain (Kshetri, 2018).

Empirical Review

Wang (2019) examined multiple companies in the food industry that had implemented blockchain to track product origins and movements. They found that blockchain's decentralized ledger enhanced visibility across the supply chain by enabling all stakeholders to view and verify transactions in real time. This heightened transparency helped to significantly reduce fraud, as tampering with product data became practically impossible. The study revealed that consumers also experienced increased trust, knowing that food origins and safety information were verified at each stage. Findings further indicated that blockchain minimized errors in data entry and improved inventory accuracy. The authors noted challenges, such as the need for substantial initial investments in blockchain infrastructure. Another issue was the lack of industry-wide standards, which complicated interoperability across different systems. They recommended that regulatory bodies work toward standardizing blockchain protocols to ensure compatibility and data security across companies. In addition, the study highlighted the potential of integrating blockchain with IoT (Internet of Things) devices to enhance tracking capabilities. For example, smart sensors could monitor temperature conditions during food transport and record them directly onto the blockchain, offering additional layers of data. Wang et al. emphasized that such integrations could make food supply chains more responsive and resilient to disruptions. They concluded that while blockchain offers numerous benefits, companies must weigh these against the costs and technical

challenges. They recommended phased implementations, where firms start with pilot programs to assess feasibility.

Francisco and Swanson (2018) understood how blockchain could improve real-time data sharing and transparency in the pharmaceutical supply chain. Using a combination of surveys and interviews with professionals in the pharmaceutical industry, they investigated blockchain's potential to prevent counterfeiting and ensure data integrity. The study found that blockchain's immutable records allowed for highly secure tracking of pharmaceuticals from manufacturer to end consumer, significantly reducing the risks of counterfeit drugs entering the supply chain. Findings showed that blockchain's transparency provided suppliers, manufacturers, and regulators with real-time access to data, which enhanced coordination and reduced delays. The authors emphasized that blockchain mitigated risks related to product safety, especially in pharmaceuticals, where ensuring authenticity is critical. Blockchain's ability to track products and manage recalls more efficiently was another major finding. The study also found that integrating blockchain with IoT could further enhance visibility by allowing sensors to capture data such as temperature and location for each shipment. Interviewees expressed enthusiasm about blockchain but noted barriers, such as the high costs of integration and the complexity of updating legacy systems. The authors recommended that pharmaceutical companies begin with pilot blockchain projects for high-risk drugs to gauge impact before full-scale deployment. They also urged companies to collaborate with technology providers to create customized solutions for pharmaceutical needs. Francisco and Swanson noted that as technology advances, blockchain could become an industry standard for securing pharmaceutical supply chains. They concluded that blockchain is particularly valuable in industries with stringent regulatory requirements. Overall, their research suggests that blockchain can transform pharmaceutical supply chains by enhancing safety and transparency.

Kshetri (2018) examined blockchain's role in enhancing supply chain transparency in developing economies, where issues like fraud and corruption are more prevalent. Using a survey of supply chain managers across various sectors in developing countries, the study found that blockchain's decentralized nature increased transparency by providing all participants with equal access to data. Findings suggested that blockchain could reduce fraudulent activities and increase trust among supply chain stakeholders, which is particularly beneficial in regions with weak institutional frameworks. The study highlighted that blockchain facilitated easier verification of product origins, which improved supply chain credibility. However, challenges were noted, such as high costs, lack of digital infrastructure, and limited expertise in blockchain technology within these regions. Kshetri pointed out that the initial investment costs could deter smaller companies from adopting blockchain, despite its benefits. The study also identified policy support as a critical factor in facilitating blockchain adoption in developing economies. Kshetri recommended that governments offer subsidies or financial incentives to make blockchain more accessible. Additionally, he suggested partnerships with international organizations to provide technical support and training. Findings indicated that blockchain adoption could empower local businesses to compete in global markets by enhancing supply chain reliability. The study recommended that policymakers develop standards for blockchain use to avoid regulatory conflicts. Kshetri concluded that while blockchain holds promise, supportive policies are essential for widespread adoption. His research underscores the need for governments in developing economies to actively support blockchain technology to maximize its benefits.

Queiroz and Wamba (2019) investigated how blockchain technology impacts visibility within the automotive industry's supply chain. Using a mixed-methods approach that combined surveys and interviews with automotive industry professionals, the authors aimed to understand blockchain's role in improving data transparency and accuracy. Findings showed that blockchain allowed for real-time tracking of parts and reduced discrepancies between different stages of the supply chain. The study noted that enhanced transparency was particularly valuable for the automotive industry, where complex networks and multi-tier suppliers make visibility challenging. Blockchain enabled better coordination among suppliers, manufacturers, and logistics providers, resulting in improved efficiency and reliability. Another key finding was that blockchain reduced the incidence of errors related to data entry, which decreased delays. Participants also noted that blockchain improved accountability by providing a tamper-proof record of transactions. However, the study identified barriers to blockchain adoption, such as high implementation costs and the need for specialized training. Queiroz and Wamba recommended that automotive companies invest in blockchain training for their workforce to ensure effective use of the technology. They also suggested starting with pilot projects in specific areas, such as parts tracking, to evaluate blockchain's impact before a full-scale rollout. The authors emphasized the importance of industry-wide standards to facilitate interoperability between different blockchain systems. They concluded that while blockchain offers promising benefits, successful implementation requires significant commitment from companies.

Kamble (2020) explored blockchain's potential to improve transparency and traceability in India's retail supply chains. The researchers used surveys distributed to retail managers and employed data analysis techniques to evaluate the impact of blockchain on supply chain visibility. Their findings showed that blockchain significantly enhanced transparency by enabling real-time data sharing across supply chain stages, thereby reducing documentation errors and delays. The study indicated that blockchain also minimized miscommunication and promoted collaboration among suppliers, distributors, and retailers. Another key finding was that blockchain contributed to improved inventory management, as all stakeholders had immediate access to stock levels. However, Kamble et al. pointed out that many retail firms in India struggled with high blockchain implementation costs and a lack of blockchain expertise. They recommended that companies collaborate with blockchain technology providers to develop cost-effective, scalable solutions tailored for retail supply chains. The authors suggested that retail firms should gradually adopt blockchain in non-critical areas before expanding usage. They concluded that blockchain could revolutionize India's retail sector by enhancing supply chain visibility and improving consumer trust.

Saberi (2019) analyzed the potential of blockchain to support environmental sustainability and visibility in global supply chains. Using qualitative research methods, Saberi and colleagues examined how blockchain could enable sustainable practices by enhancing transparency in sourcing and production. Findings indicated that blockchain made it easier to verify ethical sourcing practices, as each stage of the supply chain could be transparently tracked. The study highlighted that blockchain helped companies demonstrate compliance with environmental standards, thereby improving brand reputation. Another finding was that blockchain could facilitate the tracking of carbon emissions and waste, enabling companies to measure and manage their environmental impact. However, the authors noted that implementing blockchain in sustainable supply chains requires significant resources and alignment with corporate

sustainability strategies. Saberi et al. recommended that companies looking to integrate sustainability goals with blockchain develop a clear implementation roadmap. They also suggested collaboration with stakeholders to ensure that all parties benefit from increased visibility and accountability. The authors concluded that blockchain can play a critical role in promoting sustainable supply chains but requires committed efforts from companies and policy support.

Min (2019) assessed blockchain's role in enhancing data transparency and coordination within the logistics sector. Min conducted interviews with logistics managers and supply chain experts to gain insights into the impact of blockchain on logistics operations. The findings showed that blockchain improved real-time data sharing, which facilitated better coordination and decision-making across logistics networks. The study also found that blockchain helped reduce paperwork, minimized human errors, and improved shipment accuracy, leading to lower operational costs. Another notable finding was that blockchain improved shipment traceability, which enhanced accountability and allowed logistics firms to respond quickly to disruptions. Participants cited challenges like the complexity of integrating blockchain with existing logistics systems and the need for cross-company collaboration. Min recommended that logistics companies focus on training and upskilling their workforce in blockchain technologies. He also suggested that logistics firms work closely with technology providers to develop blockchain solutions that fit their operational needs. The study concluded that while blockchain offers considerable benefits in visibility and coordination, long-term success requires strategic investment and industry cooperation.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low-cost advantage as compared to field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

FINDINGS

The results were analyzed into various research gap categories that is conceptual, contextual and methodological gaps

Conceptual Gaps: While existing studies, such as those by Wang (2019) and Kshetri (2018), demonstrate that blockchain enhances transparency, traceability, and data security, there is limited research on the interaction between blockchain and other technologies like AI and IoT in achieving visibility. This gap highlights the need for conceptual frameworks that explore how blockchain synergizes with advanced technologies to create more dynamic and adaptive supply chains. Furthermore, while studies mention benefits in reducing fraud and errors, there is insufficient exploration of blockchain's impact on real-time decision-making and predictive analytics within the supply chain, leaving a gap in understanding its full potential in strategic planning.

Contextual Gaps: Most research focuses on specific sectors such as food (Wang, 2019), pharmaceuticals (Francisco & Swanson, 2018), and retail (Kamble, 2020), overlooking industries with distinct challenges in traceability, such as agriculture and construction. Blockchain's application in these diverse sectors remains underexplored, suggesting a need for context-specific studies to understand how blockchain could enhance visibility in varied supply chains.

Additionally, while studies like Saberi (2019) connect blockchain to sustainability, they do not fully address the practical challenges that companies face in aligning blockchain with sustainability goals, especially in high-impact sectors. Understanding how blockchain affects industries with different regulatory and operational complexities could enrich contextual insights.

Geographical Gaps: Research on blockchain's impact on supply chain visibility is heavily concentrated in specific regions, such as Asia (India in Kamble, 2020 and automotive sector in Queiroz & Wamba, 2019) and developing economies (Kshetri, 2018). Limited research exists on blockchain adoption in supply chains across other regions like Latin America, Africa, and the Middle East, where unique regulatory, infrastructural, and economic conditions may alter the technology's effectiveness. Geographically diverse studies could provide insights into how regional factors, such as policy support and digital infrastructure availability, influence blockchain's visibility benefits. For example, there is a gap in understanding the challenges and opportunities for blockchain-based transparency in Sub-Saharan Africa, where supply chains face frequent logistical and economic barriers.

CONCLUSION AND RECOMMENDATIONS

Conclusions

The impact of blockchain implementation on supply chain visibility reveals that this technology holds transformative potential for enhancing transparency, traceability, and trust across complex supply networks. By enabling secure, decentralized data sharing, blockchain can provide real-time visibility into every stage of the supply chain, reducing information asymmetries and increasing accountability among supply chain partners. Studies show that blockchain not only enhances data integrity and reduces the risk of fraud but also enables more efficient decision-making through automated smart contracts and real-time tracking. However, successful blockchain adoption requires addressing challenges such as interoperability, high implementation costs, and resistance to data-sharing among partners. Ultimately, the strategic implementation of blockchain in supply chains can provide companies with a competitive advantage by fostering a more transparent, responsive, and resilient supply chain ecosystem.

Recommendations

Theory

To advance theoretical understanding, future research should develop frameworks that analyze the multi-layered impacts of blockchain on various aspects of supply chain visibility, including traceability, transparency, and data sharing. Scholars can integrate information systems theory with supply chain management concepts to examine how blockchain affects data integrity and trust among supply chain partners. Additionally, employing transaction cost economics (TCE) within blockchain research could help understand how reducing transaction costs and increasing information transparency with blockchain enhances supply chain visibility. Developing these theories would create a foundation for further research on blockchain's transformative role in supply chain dynamics.

Practice

For practitioners, the implementation of blockchain technology offers significant potential to improve real-time visibility, data accuracy, and trust within the supply chain. It is recommended

that businesses adopt blockchain-based systems gradually, starting with pilot programs to test feasibility and impact on visibility in specific supply chain areas. Supply chain managers should focus on training employees to use blockchain platforms, emphasizing the use of smart contracts and real-time data analytics to track and verify shipments. Additionally, organizations should collaborate with blockchain technology providers to tailor blockchain solutions that address industry-specific visibility challenges, such as product traceability in food and pharmaceuticals. Standardizing data formats and protocols across the supply chain network can also enhance the effectiveness of blockchain in promoting seamless visibility.

Policy

Policymakers should develop standards and regulatory guidelines for blockchain implementation in supply chains to ensure secure and ethical data usage. Regulatory bodies can create frameworks that mandate transparency and data-sharing practices for companies using blockchain, particularly in sectors with high consumer interest in product origins, like food, pharmaceuticals, and luxury goods. Governments could also introduce blockchain-specific tax incentives or grants to encourage early adoption, particularly for small and medium-sized enterprises (SMEs) that may lack resources for initial blockchain investments. Moreover, policies promoting cross-border blockchain interoperability standards would facilitate smoother global supply chain operations and enhance supply chain visibility on an international scale.

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